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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re PATENT APPLICATION OF

Inventor(s): ANDERSSON, Conny et al

Filed: Herewith

Title: METHOD FOR DETERMINING THE NEEDED AMOUNT OF STRUCTURE MODIFYING AGENT TO BE ADDED TO CAST IRON

June 14, 2001

PRELIMINARY AMENDMENT

Hon. Commissioner of Patents
Washington, D.C. 20231

Sir:

Please amend this application as follows:

IN THE SPECIFICATION:

At the top of the first page, just under the title, insert

☒ --This application is the National Phase of International Application PCT/SE99/02392 filed December 16, 1999 which designated the U.S. and that International Application

☒ was ☐ was not published under PCT Article 21(2) in English.--

Respectfully submitted,

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METHOD FOR DETERMINING THE NEEDED AMOUNT OF STRUCTURE MODIFYING AGENT TO BE ADDED TO CAST IRON

The present invention relates to an improved method for predicting the microstructure in which a cast iron melt, having a composition with a carbon equivalent near the eutectic point of the iron-carbon phase diagram, will solidify. The invention also relates to an apparatus for carrying out the method.

Background of the invention

WO86/01755 (incorporated by reference) discloses a method for producing compacted graphite cast iron by using thermal analysis. A sample is taken from a bath of molten cast iron and this sample is permitted to solidify during 0.5 to 10 minutes. The temperature is recorded simultaneously by two temperature-responsive means, one of which is arranged in the centre of the sample and the other in the immediate vicinity of the vessel wall. So-called cooling curves representing temperature of the iron sample as a function of time are recorded for each of the two temperature-responsive means. According to this document, it is then possible to determine the necessary amount of structure-modifying agents that must be added to the melt in order to obtain the desired microstructure. However, the cooling curves disclosed in this document are rather uniform and no variations are disclosed.

In order to accurately determine the graphite microstructure in cast iron specimens, conventional thermal analysis techniques, such as the one disclosed in WO 86/01755, require cooling curves where the first thermal arrest caused by austenite formation is distinctly separated from heat release caused by the onset of eutectic solidification. However, sometimes cooling curves are obtained without such a distinctly separated thermal arrest. This is the case when the molten cast iron solidifies as eutectic or hyper-eutectic iron. Until now, it has not been possible to use cooling curves corresponding to near eutectic cast iron for monitoring graphite growth.

WO93/20965 teaches that hyper-eutectic melts, where graphite nucleates before iron, do not provide a distinct plateau as the temperature crosses the liquidus line. This is correctly attributed to the fact that graphite crystallisation has a lower latent heat release than iron.

By placing a small amount of low-carbon iron in the melt, the low-carbon iron partially dissolves locally while the sample is still molten. As the sample cools, the relatively pure iron surrounding the remaining solid portion of the nail begins to solidify because of its lower carbon equivalent (CE). Ultimately, as the sample volume cools below the liquidus line, the remaining solid volume of nail, the surrounding low CE and the melted portion of the nail begin to solidify and "trigger" the solidification in an otherwise hyper-eutectic melt. The net result is that an austenite arrest plateau appears on the cooling curve.

WO93/20965 also states that the temperature difference (ΔT) between T_δ and $T_{c\,max}$ can be used to establish a correlation with the carbon equivalent. However, WO93/20965 refers to hyper-eutectic melts, i.e. melts where the carbon equivalent is so high that the release of heat from the primary solidification does not coincide with the minima of the cooling curve (in the hatched region of Fig. 2(a) of WO93/20965). Accordingly, the primary solidification and the eutectic solidification are separate.

None of the above cited references discuss anything about carrying out thermal analysis on cast iron melts in order to determine the carbon equivalent of melts which are near-eutectic. Moreover, WO93/20965 suggests measurements on melts having a carbon equivalent of up to 4.7%. It is disadvantageous to reach such high values because of graphite flotation and the degeneration of graphite shape. Likewise, the method of WO93/20965 is disadvantageous in that it requires an extra addition of low-carbon steel or iron to the sampling vessel, and accordingly lead to higher costs and a more laborious method.